

ARMY RESEARCH LABORATORY



## Human Factors Engineering Assessment of the Mini-Flail System

Patricia M. Burcham

ARL-TN-79

NOVEMBER 1996

19970213 016

DTIC QUALITY INSPECTED

Approved for public release; distribution is unlimited.

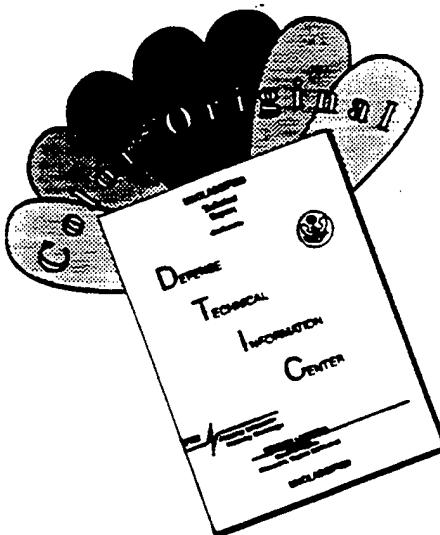
**John Deere® is a registered trademark of John Deere Corp.**

**The findings in this report are not to be construed as an official Department of the Army position  
unless so designated by other authorized documents.**

**Citation of manufacturer's or trade names does not constitute an official endorsement or approval of  
the use thereof.**

**Destroy this report when it is no longer needed. Do not return it to the originator.**

# DISCLAIMER NOTICE



THIS DOCUMENT IS BEST  
QUALITY AVAILABLE. THE COPY  
FURNISHED TO DTIC CONTAINED  
A SIGNIFICANT NUMBER OF  
COLOR PAGES WHICH DO NOT  
REPRODUCE LEGIBLY ON BLACK  
AND WHITE MICROFICHE.

# **Army Research Laboratory**

Aberdeen Proving Ground, MD 21005-5425

---

---

ARL-TN-79

November 1996

---

## **Human Factors Engineering Assessment of the Mini-Flail System**

**Patricia M. Burcham**  
Human Research & Engineering Directorate

---

Approved for public release; distribution is unlimited.

---

---

---

## Abstract

---

A human factors engineering (HFE) assessment was conducted on the mini-flail system whose basic mission is to neutralize anti-personnel hazards. The assessment revealed numerous HFE design problem areas. Recommendations for design modifications to fulfill the military standard requirements are discussed.

## CONTENTS

INTRODUCTION .....	3
BACKGROUND .....	3
OBJECTIVE .....	4
PROCEDURE .....	4
Control, Display, and Labeling .....	4
Lighting .....	5
Interviews and Observations .....	5
FINDINGS .....	5
Control, Display, and Labeling .....	5
Lighting .....	9
Interviews and Observations .....	9
TECHNICAL ASSESSMENT .....	12
Control, Display, and Labeling .....	12
Lighting .....	15
Informal Interviews and Observations .....	15
CONCLUSIONS AND RECOMMENDATIONS .....	18
REFERENCES .....	21
APPENDIX	
A. Instructions for Proper Placement of Mini-Flail Stencils and Labels .....	23
DISTRIBUTION LIST .....	31
REPORT DOCUMENTATION PAGE .....	33
FIGURES	
1. The Mini-Flail System .....	4
2. The Mini-Flail Wireless Remote .....	6
3. Controls on the Exterior Rear Panel of the Mini-Flail .....	8
4. The Junction Box Labels .....	10

5. The Two Exterior Springs, Two Interior Shocks, and Support Rod, Critical for Sustaining the Hood in the Opened Position .....	11
6. The Flail Head in Motion .....	14
7. The Carriage That Houses the Chains .....	17

## TABLES

1. Mini-Flail Control and Display Measurements .....	7
2. Mini-Flail Hazard Severitys .....	19

# HUMAN FACTORS ENGINEERING ASSESSMENT OF THE MINI-FLAIL SYSTEM

## INTRODUCTION

The Soldier Systems Control Branch (SSCB), Human Research & Engineering Directorate (HRED) of the U.S. Army Research Laboratory was tasked by the Office of Special Technology, Fort Washington, Maryland, to conduct a human factors engineering (HFE) assessment of the mini-flail system. The HFE assessment was conducted at Aberdeen Proving Ground, Maryland, from 5 through 7 September 1995. A thorough HFE assessment was not possible because of limited item availability. ARL devoted much of the allotted time to labeling the system and developing a training video before its release to U.S. troops in Bosnia.

## BACKGROUND

The basic mission of the mini-flail is to neutralize (by detonation, mechanical destruction, or displacement from chosen path) a variety of anti-personnel hazards, such as anti-personnel land mines, booby traps, improvised anti-personnel explosive devices, scatterable anti-personnel mines, and dud air-dropped cluster munitions by use of chains attached to a spinning shaft. Because of hazards associated with explosive devices, flailing operations are conducted from a safe stand-off distance via radio remote control.

The mini-flail consists of a John Deere® 375 skid steer loader chassis with a Yamar 3-cylinder diesel engine. This system is fully armored with steel, aluminum, and SPECTRA (a ballistic material similar to KEVLAR), possesses four solid foam-filled tires, and is controlled with a commercial radio control. The mini-flail weighs approximately 2,200 pounds and is about 4 feet wide, 4 feet high, and 9 feet long.

The flail section consists of a self-articulating, hydraulically powered shaft with 84 chains, each 1.4 feet long, attached with break rods, providing a 42-inch clearing width. The chain assembly can be rotated forward to detonate mines or backwards to clear objects out of its path. It operates at approximately 120 rpm and operates at least 20 hours on a single 6-gallon tank of diesel fuel. The estimated life of the 9-volt battery housed within the transmitter is 8 hours.

## OBJECTIVE

The objective of this assessment was to determine whether the design and prescribed procedures of the mini-flail system (see Figure 1) conform to the military requirements and standards for human factors engineering.



Figure 1. The mini-flail system.

## PROCEDURE

Reference Test Operations Procedures (TOPs) 1-2-610, 1-1-060, and 1-1-012 and Test and Evaluation Command (TECOM) Pamphlet 602-1 (TECOM, 1975).

### Control, Display, and Labeling

All controls and displays of the mini-flail's radio remote control transmitter (Model RCT 918-7) were assessed. Control separation and control dimensional measurements were measured and compared to the requirements of MIL-STD-1472D (Department of Defense, 1989) to

determine conformance. Observations were made of all controls, displays, and labeling with respect to HFE design practices in accordance with MIL-STD-1472D. Any nonconformance found was documented and assessed as to the effect on the operator's performance. Other controls and displays on the mini-flail were only assessed as deemed necessary by the human factors specialist.

### Lighting

A cursory review of the mini-flail system was made to determine adequate lighting for various environmental conditions.

### Interviews and Observations

Informal interviews were conducted to determine subjects' opinions about the overall operation and performance of the mini-flail system. Observations were made by HFE specialists to gain additional information about any HFE-related problem areas. Informal interview comments and observations made by HFE specialists were documented to provide subjective input to the assessment of the mini-flail system. These interviews and observations were used to augment data from other HFE assessments and integrated into the analysis.

## FINDINGS

### Control, Display, and Labeling

The mini-flail remote (see Figure 2) control and display measurements and minimum requirements are provided in Table 1. Physical measurements were not made of the few controls on the mini-flail since the human factors specialist did not deem it necessary after cursory examination.

The following labeling inadequacies were documented throughout the HFE assessment:

- (1) The red push button on top of the wireless remote used to begin flailing operations was not labeled. This push button acts as a secondary sequential control for flailing to limit accidental actuation of the flail toggle switch between the throttle and winch toggle switches.
- (2) The battery meter, located on the remote face (center, first row), was not labeled.

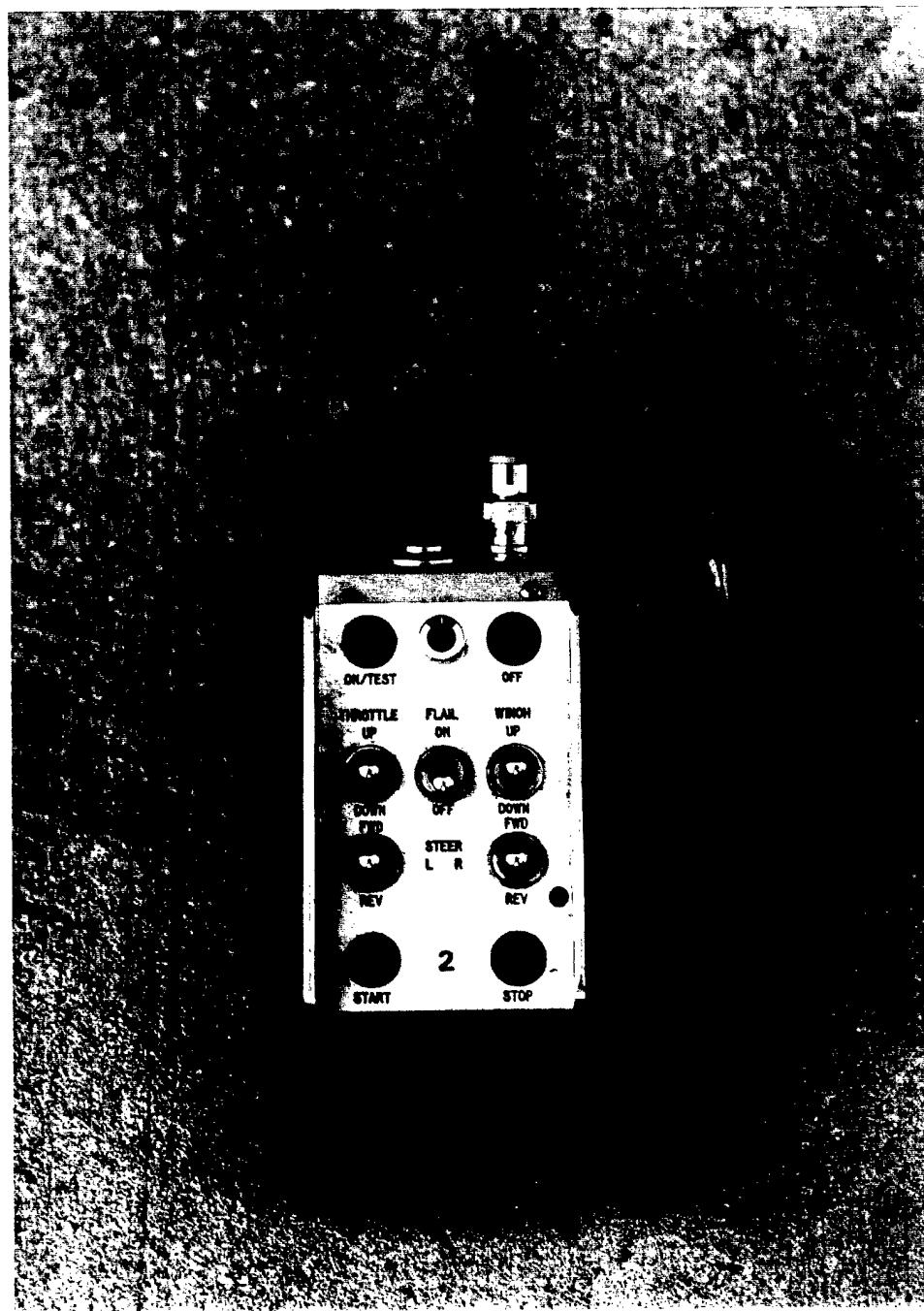


Figure 2. The mini-flail wireless remote.

Table 1  
Mini-Flail Control and Display Measurements

Control	Measured (in.)	Minimum Requirement <sup>a</sup> (in.)
Separation between		
On/test push button and throttle toggle switch	1.2	0.5
Off push button and winch toggle switch	1.2	0.5
Throttle and flail toggle switches	<sup>b</sup> 0.5	0.8
Flail and winch toggle switches	<sup>b</sup> 0.5	0.8
Throttle and L steer toggle switches	<sup>b</sup> 0.7	0.8
Winch and R steer toggle switches	<sup>b</sup> 0.7	0.8
L steer toggle switch and start push button	0.7	0.5
R steer toggle switch and stop push button	0.7	0.5
Start and stop push buttons	1.2	0.5
Length		
Toggle switches	<sup>b</sup> 0.4	<sup>c</sup> 0.5 <sup>d</sup> 1.5
Diameter		
Toggle switches	0.2	0.1
Push buttons	<sup>b</sup> 0.3	0.4

<sup>a</sup>Minimum requirement in accordance with MIL-STD-1472D.

<sup>b</sup>Denotes noncompliance with MIL-STD-1472D.

<sup>c</sup>Use by bare finger.

<sup>d</sup>Use with heavy handwear.

(3) All controls on the rear of the mini-flail, including the emergency stop push button, two toggle switches, and ignition, were either not labeled or labeled inappropriately (see Figure 3).

(4) Fuel fill on the mini-flail was not labeled.

(5) Tie down and lift points on the mini-flail were not labeled.

(6) Trip wire and antenna positions were not labeled.

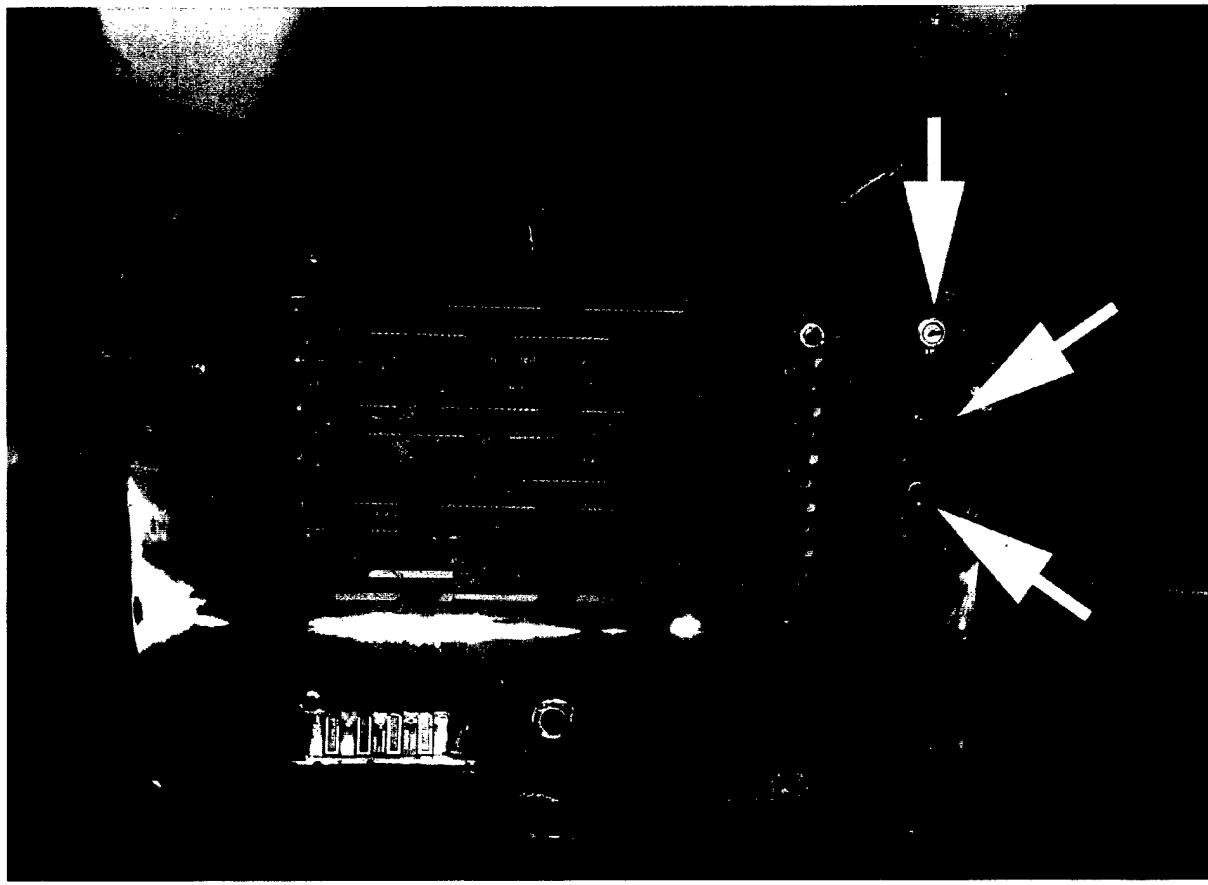


Figure 3. Controls on the exterior rear panel of the mini-flail (either not labeled or labeled inadequately).

- (7) The mini-flail hood had no warning or caution labels to make personnel aware of potential crushing hazards.
- (8) The mini-flail possessed no warning to personnel of needed clearances during flailing and sweeping operations.
- (9) The emergency stop push button on the remote was difficult to locate quickly since there were three red push buttons. The secondary flail push button, located atop the remote, the "off" push button, and the "stop" push button were all red.
- (10) No instruction plate existed.
- (11) The remote lacked needed descriptive labeling for some of its controls.

- (12) There was no automatic battery power indicator.
- (13) There were no nonskid surfaces for stepping on the hood.
- (14) The junction box possessed only temporary labeling that was not horizontally oriented (letters positioned for reading from left to right) (see Figure 4).
- (15) Cables on the interior housing lacked adequate labeling.

### Lighting

The mini-flail system does not possess lighting of any kind. Therefore, this system is incapable of being effectively used for nighttime mine-clearing missions unless personnel use night vision equipment or an external light source.

### Interviews and Observations

Two engineers (one Government employee and one contractor) in the program were interviewed about operation and performance of the mini-flail system. The following were documented during informal interviews and observations:

- (1) The emergency stop push button on the rear of the mini-flail must be pushed and held inward until the engine shuts down. This time lag (approximately 2 or 3 seconds) between the operator pushing the button and the engine shutting down is unacceptable.
- (2) There is no indication on the remote as to whether the mini-flail power is on or off.
- (3) The mini-flail does not automatically reset to low throttle when it stalls. It is necessary for the operator to ensure the item is at low throttle before starting it.
- (4) The red "stop" push button on the remote stops the engine, not the mini-flail. Therefore, after the engine stops, the mini-flail drifts to a stop.
- (5) A spin steer hampers the engine, often causing it to stall. Turns must be made by pulsing or repeatedly activating then releasing the steer toggle switches on the remote.
- (6) No automatic indicator exists to warn the operator that the battery is dying. The operator is required to constantly monitor battery power by pressing the "test" push button.

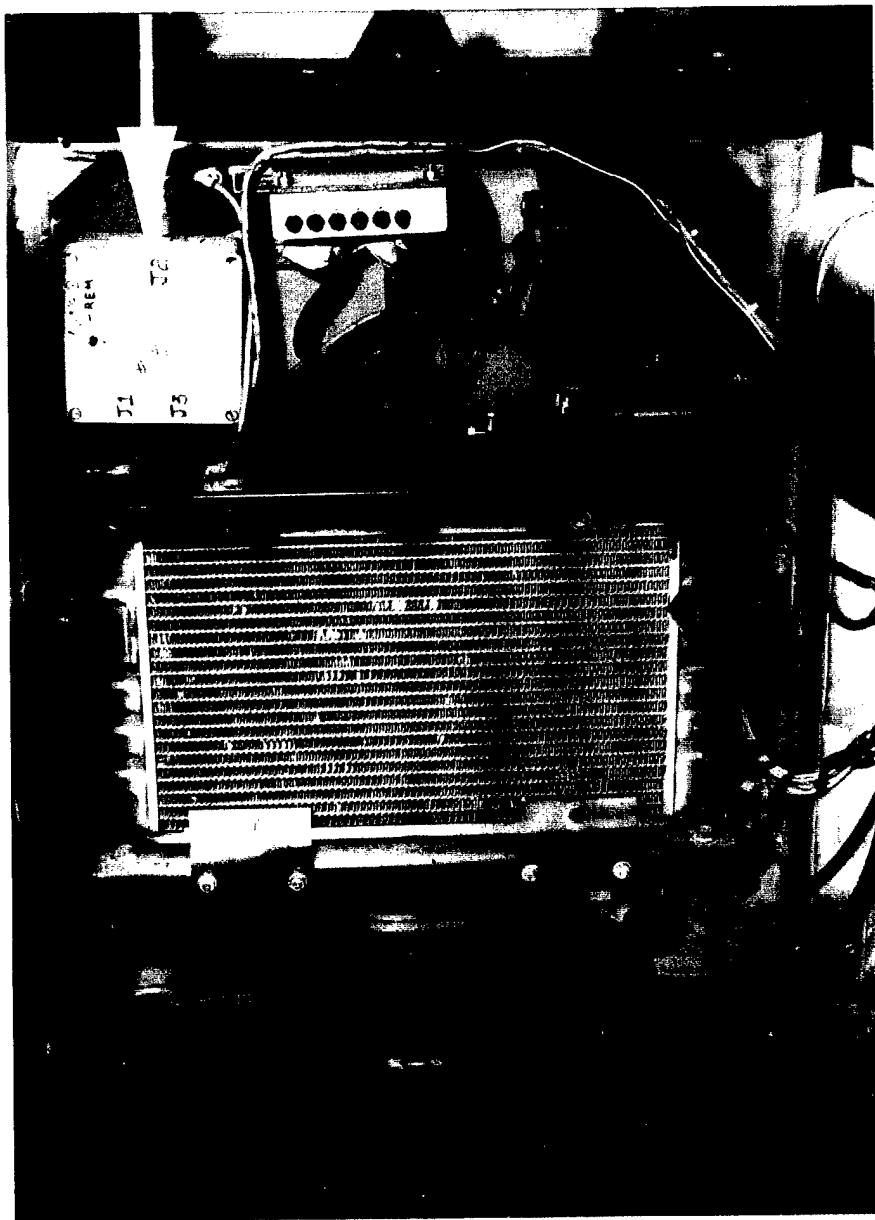


Figure 4. The junction box labels (should be permanent, and the lettering should be oriented horizontally).

(7) The mini-flail is best operated while the operator stands behind it. All the control functions would be reversed if the operator were to stand in front of and face the mini-flail.

(8) The mini-flail hood weighs approximately 300 lb. The hood can cause critical injury to personnel if the support rod is not put in place after being opened. The two exterior springs, two interior shocks, and support rod (see Figure 5) are critical elements for sustaining the hood in an opened position for preventive maintenance, checks, and services (PMCS) and other service required by the system.

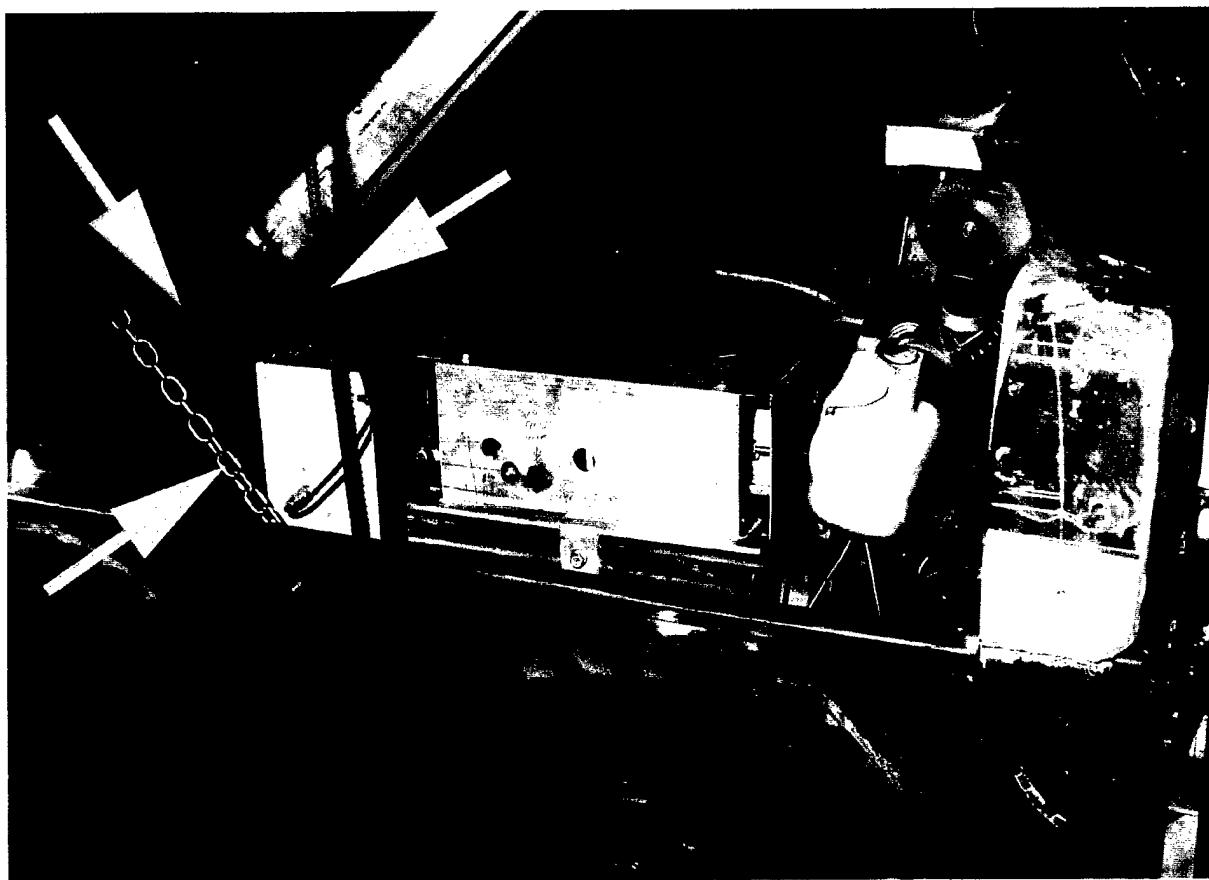


Figure 5. The two exterior springs, two interior shocks, and support rod, critical for sustaining the hood in the opened position.

(9) The mini-flail does not tend to go in a straight line when it is driven in reverse.

(10) Chains limit the mini-flail's upward travel.

(11) During flailing and sweeping actions, chains become entangled.

(12) Personnel who had operated the mini-flail agreed that the winch “up” and “down” control positions should be reversed citing similar control-function positions in other commonly used vehicles such as forklifts.

(13) The “off” and “on” positions of the toggle on the exterior rear panel of the mini-flail are incorrect.

(14) Note. The U.S. Army Test and Evaluation Command (TECOM) reported the average range of operation of the hand-held wireless remote to be 207 meters (679 feet) (TECOM, 1995). According to the Operator’s Manual of Instruction (U.S. Army Belvoir Research, Development, and Engineering [RD&E] Center, 1992), the minimum safe distance from all mines, submunitions, and shaped charges during flailing operations is 914 meters (1000 yards). Therefore, the wireless remote would only transmit within the flailing operation danger zone. ARL was able to improve the transmission range considerably to approximately 600 meters; however, it is still within the danger zone as stated by the Belvoir RD&E Center. Because of scheduling constraints, ARL was unable to adequately investigate the minimum safe flailing operation range and average transmission range capability of the wireless remote. Data available about these issues proved to be contradictory from one document to another.

(15) It was observed via video tape (mini-flail demonstration) that the operator had poor visibility during dry terrain conditions, causing a dust cloud to surround the mini-flail. The minimum safe distance from all mines, submunitions, and shaped charges during flailing operations (specified in paragraph [14]) causes inadequate visibility of the mini-flail.

## TECHNICAL ASSESSMENT

### Control, Display, and Labeling

The separations between the throttle and flail toggle switches, flail and winch toggle switches, throttle and L-steer toggle switches, and winch and R-steer toggle switches did not meet the minimum requirement of MIL-STD-1472D. Toggle switch lengths did not comply with the minimum requirement for use by bare finger or heavy handwear. The diameter of the push buttons on the face of the remote did not meet the minimum requirement of MIL-STD-1472D, Figure 13.

Labeling inadequacies documented were assessed as follows:

(1) Labels, legends, placards, signs, or markings shall be provided whenever it is necessary for personnel to identify, interpret, follow procedures, or avoid hazards, except when it is obvious to the user what an item is and how it is to be used, in accordance with MIL-STD-1472D, paragraph 5.5.1.1. The red push button on top of the remote, used to begin flailing action should be properly labeled.

(2) The battery meter should be labeled in accordance with MIL-STD-1472D, paragraph 5.5.1.1.

(3) The emergency stop push button, two toggle switches, and ignition should be labeled in accordance with MIL-STD-1472D, paragraph 5.5.1.1. Labels shall be clear, distinct, have high contrast, be mounted so as to minimize wear or obscurement by grease, grime, or dirt, and remain legible for the overhaul interval of the item on which they are mounted in accordance with MIL-STD-1472D, paragraph 5.5.4.5.

(4) The fuel fill should be labeled in accordance with MIL-STD-1472D, paragraph 5.5.1.1.

(5) Tie down and lift points should be labeled in accordance with MIL-STD-1472D, paragraph 5.5.1.1. Each unit, assembly, subassembly, and part shall be labeled with a clearly visible, legible, and meaningful name, number, code, or symbol, as applicable, in accordance with MIL-STD-1472D, paragraph 5.5.6.1.1.

(6) Trip wire and antenna positions should be labeled in accordance with MIL-STD-1472D, paragraphs 5.5.1.1 and 5.5.6.1.1.

(7) The mini-flail should possess labels on or near the hood to warn personnel of potential dangers in accordance with MIL-STD-1472D, paragraph 5.13.2.1.

(8) The mini-flail should possess warning labels to make personnel aware of the needed clearances during flailing and sweeping operations (see Figure 6) in accordance with MIL-STD-1472D, paragraph 5.13.2.1.

(9) Emergency controls shall be located where they can be seen and reached with minimum delay in accordance with MIL-STD-1472D, paragraph 5.1.2.3.8.

(10) An instruction plate should be included on the mini-flail to highlight or summarize important procedures to be followed for starting, flailing and sweeping operations, and emergency or routine stopping. It is recommended that the instructional placard be located on

the underside of a cover that flips up. The cover, to be added, would also act to protect the remote control and display panel.

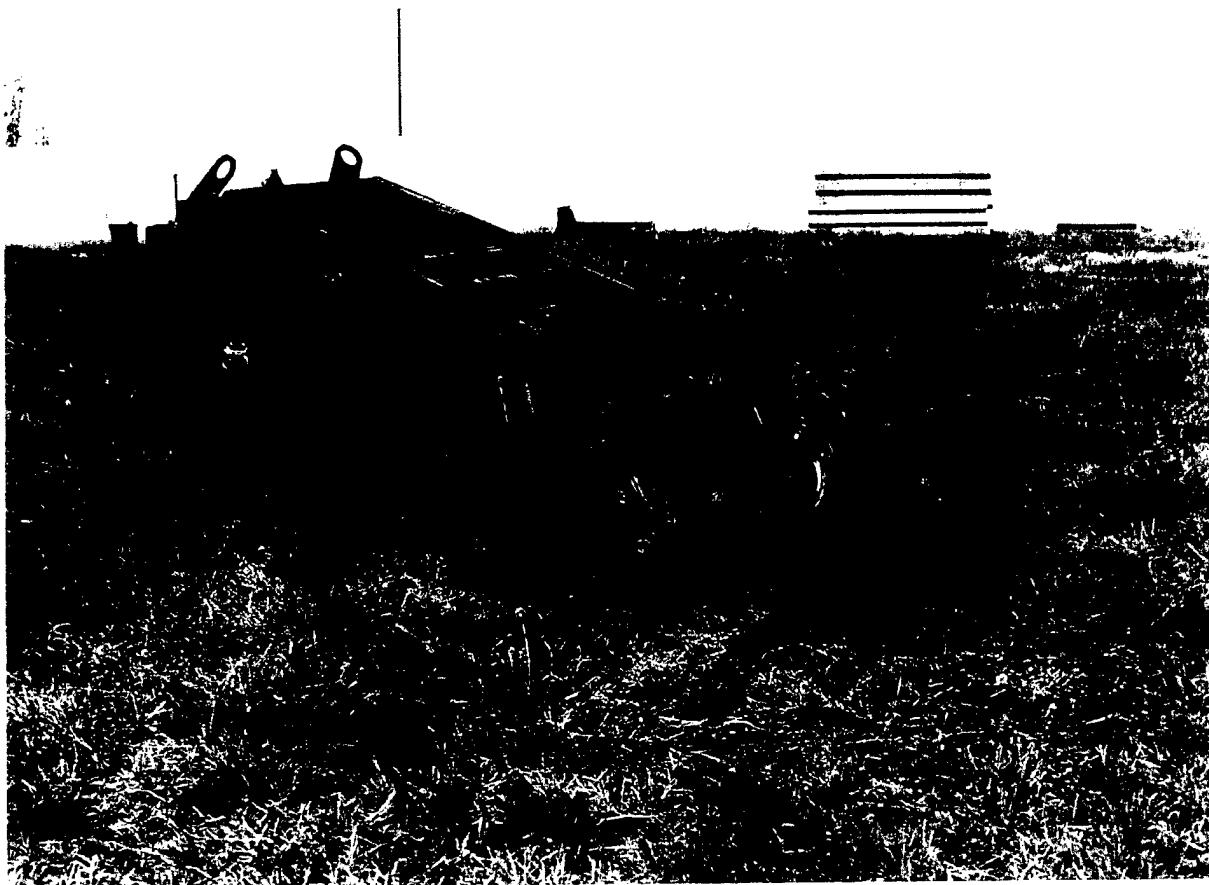


Figure 6. The flail head in motion.

(11) The remote control should possess more descriptive labeling for its controls. The "on/test" push button should read, "remote on/test" and the "off" push button should read, "remote off." The "start" push button should read, "engine start" and the "stop" push button should read "engine stop."

(12) It is recommended that a continuous, automatic display be provided to show battery power status in order to eliminate the need for the user to monitor power by pressing the on/test push button.

(13) "No step" labeling is required on the top of the hood to prevent personnel injury or equipment damage in accordance with MIL-STD-1472D, paragraph 5.13.2.5.

(14) The junction box labeling needs to be made permanent in accordance with MIL-STD-1472D, paragraph 5.5.4.5. Letter orientation should be horizontal so that the letters may be read quickly and easily from left to right in accordance with MIL-STD-1472D, paragraph 5.5.2.1.

(15) All cables should be labeled to identify the equipment to which they belong and the connector to which they mate in accordance with MIL-STD-1472D, paragraph 5.9.13.8. All replaceable cables and wires need to be identified with color or number codes in accordance with MIL-STD-681 (Department of Defense, 1990).

## Lighting

Lighting should be provided on the mini-flail and remote for use at nighttime. The control panel on the wireless remote should be illuminated in accordance with MIL-STD-1179D (Department of Defense, 1986) and MIL-STD-1472D.

## Informal Interviews and Observations

HFE problems noted were assessed as follows:

(1) The time lag between the response of a system to a control input shall be minimized in accordance with MIL-STD-1472D, paragraph 5.1.3.2. Feedback about control response adequacy shall be provided as rapidly as possible in accordance with MIL-STD-1472D, paragraph 5.1.1.4. Push buttons should be used when a control or an array of controls is needed for momentary contact in accordance with MIL-STD-1472D, paragraph 5.4.3.1.1.1. The emergency stop push button on the rear of the mini-flail should only require button depression. It should not have to be depressed and held before the engine stops. The push button should respond immediately to control input.

(2) Feedback about system status (i.e., power on/off) should be provided in accordance with MIL-STD-1472D, paragraph 5.1.1.4. Further, visual displays should be used to provide the user with a clear indication of equipment or system conditions in accordance with MIL-STD-1472D, paragraph 5.2.1. Lights, including those in illuminated push buttons, shall display equipment response, not merely control position in accordance with MIL-STD-1472D, paragraph 5.2.2.1.2.

- (3) It is recommended that the mini-flail automatically reset to low throttle after an engine stall to avoid potential system damage.
- (4) Labeling (instructional placard) and manual notation should be made to caution the user that the “stop” push button only kills the engine while the mini-flail drifts to a stop in accordance with MIL-STD-1472D, paragraph 5.5.1.1.
- (5) Proportional controls are needed to resolve engine stall during a spin steer.
- (6) A battery power indicator is needed to provide immediate feedback to the user as to the battery status.
- (7) Labeling (instructional placard) and manual notation should be made to caution the user of the reversal of controls and their respective functions when the operator is facing the front of the mini-flail versus the rear in accordance with MIL-STD-1472D, paragraph 5.5.1.1.
- (8) Labeling and manual notation should be made to warn the user of potential critical injury from the heavy hood if the exterior springs, two interior shocks, and support rod are not in place and functional in accordance with MIL-STD-1472D, paragraph 5.13.2.1. High wind may cause the hood to close or cause the mini-flail to flip forward during maintenance procedures.
- (9) Labeling (instructional placard) and manual notation should be made to caution the user that the mini-flail does not tend to back in a straight line in accordance with MIL-STD-1472D, paragraph 5.5.1.1.
- (10) Manual notation should be made to address the chains limiting the mini-flail’s upward travel in accordance with MIL-STD-1472D, paragraph 5.5.1.1.
- (11) The carriage housing the chains should be modified to prevent the chains from becoming entangled (see Figure 7). It is recommended that the instruction manual and plate warn personnel that the flail chains become entangled and must be manually untangled after use.
- (12) Personnel interviewed argued that the winch toggle switch should move down in order to move the winch up, being consistent with material-handling equipment (MHE). However, MIL-STD-1472D, paragraph 5.4.1.2.1 dictates that the direction of control movement shall be consistent with the related movement of an associated display, equipment component, or vehicle.

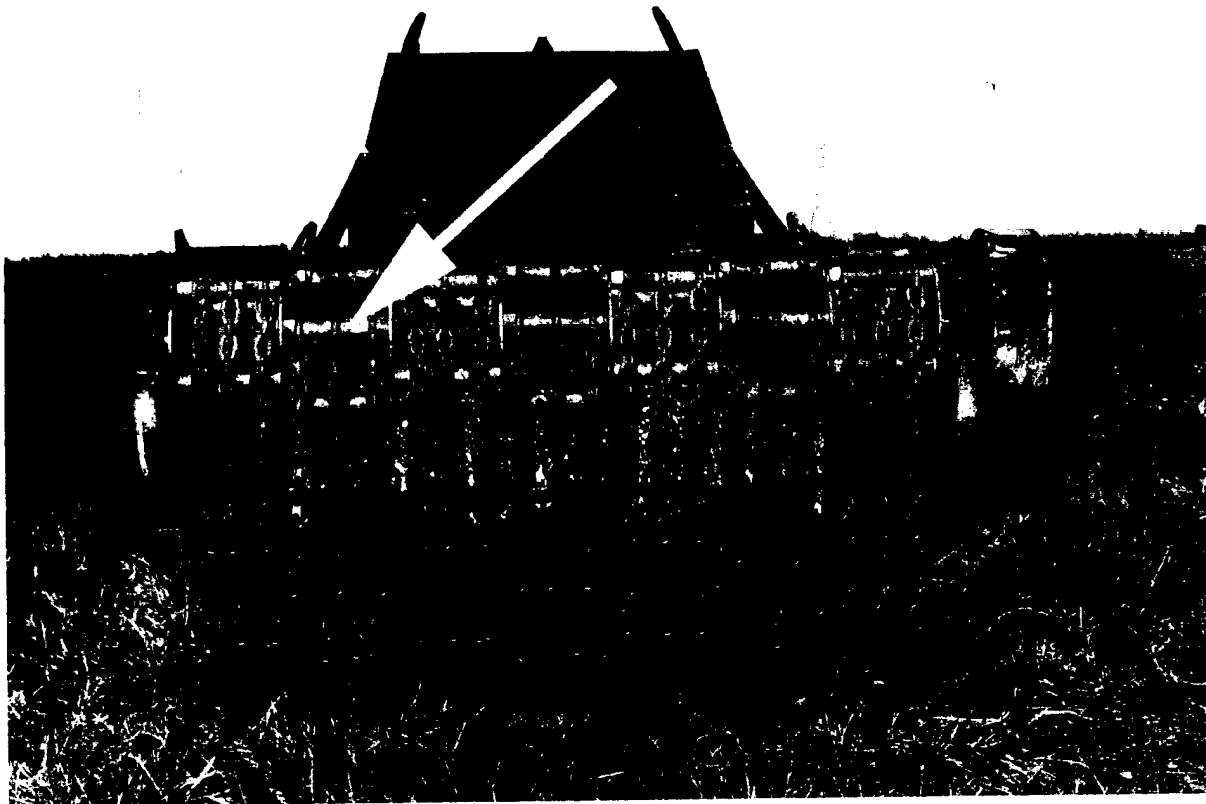


Figure 7. The carriage that houses the chain (this should be modified to prevent the chain from becoming entangled).

(13) The "off" and "on" operational positions of the toggle switch located on the exterior rear panel of the Mini-flail need to be corrected so that "off" is the left position and "on" is the right position. Generally, control movement forward, clockwise, to the right, or up, or pressing a control shall turn the equipment or component on, cause quantity to increase, or cause forward, clockwise, to the right, or upward movement in accordance with MIL-STD-1472D, paragraph 5.4.1.2.1. Labeling should then be modified to correspond with the appropriate operational positions.

(14) The reported transmission range is a critical issue that should be adequately addressed. ARL intends to further evaluate this issue as funding and scheduling permit in Fiscal Year 97.

(15) On-board cameras are recommended to provide feedback to the operator regarding terrain conditions (holes, hills, obstructions, and other obstacles) and possibly improve visibility, which had been made poor by flailing operations in dry terrain.

## CONCLUSIONS AND RECOMMENDATIONS

The human factors engineering assessment (HFEA) of the mini-flail system revealed a number of human-item interface-related hazards. These are summarized in a hazard severity table in Table 2. Color coding, separations, and dimensions of controls on the mini-flail and the wireless remote control need modification if they are to meet the requirements set forth in MIL-STD-1472D. Labeling to include identifications, instructions, cautions, and warnings should be addressed to promote safety and human factors standards.

If the system is intended to be used during nighttime or during darkened conditions, a lighting system should be incorporated. Improvement is needed for adequate system response time to activate emergency stop controls and feedback is necessary to provide the user system status.

It is suggested that on-board cameras be considered to improve user friendliness and greatly enhance remote control operations. During field trials, the operator experienced poor visibility of the mini-flail system during dry terrain conditions. The flailing operation caused a dust cloud to surround the mini-flail. The operator is required to be a safe distance from the system (distance depends on the type of operation being performed) during operation, which also limits visibility. On-board cameras may aid the operator in identifying path obstructions, hills, holes, and obstacles that could cause extensive damage or leave the vehicle stranded.

Table 2  
Mini-Flail Hazard Severity

Description	Classification	Rating
1. Inadequate control separations	III-C	Shortcoming
2. Inadequate toggle switch length	III-E	Suggested Improvement/Acceptable
3. Inadequate push button diameter	III-E	Suggested Improvement/Acceptable
4. No label on push button for wireless remote	III-B	Shortcoming
5. No label for the battery meter on the wireless remote	IV-C	Acceptable
6. Inadequate labeling of all existing controls located on the rear panel	II-C	Deficiency
7. No labels for tie down and lift points	III-C	Shortcoming
8. No labels for trip wire and antenna positions	III-D	Suggested Improvement
9. No warning or caution labels to warn of crushing hazard	II-C	Deficiency
10. No warning for necessary clearances during Mini Flail operations	II-C	Deficiency
11. Difficult to distinguish emergency stop on wireless remote	II-C	Deficiency
12. No instruction plate provided	III-C	Shortcoming
13. Inadequate labeling of wireless remote controls	III-B	Shortcoming
14. No automatic battery power indicator	III-B	Shortcoming
15. No nonskid surface for the hood	III-C	Shortcoming
16. Inadequate labeling of the junction box	III-C	Shortcoming
17. Inadequate labeling of cables located on the interior housing	III-D	Suggested Improvement
18. No lighting provided for the mini-flail or its wireless remote	I-D	Deficiency
19. Time lag for depression of emergency stop and system reaction	III-B	Shortcoming
20. No power indicator for mini-flail power	III-C	Shortcoming
21. Lack of automatic reset to low throttle when after a stall	III-C	Shortcoming
22. "Stop" control on the remote stops the engine only	III-C	Shortcoming
23. Engine stall during a spin steer	III-C	Shortcoming
24. No automatic indicator to warn operator of low battery	III-C	Shortcoming
25. Control functions are reversed when the operator stands in front of the mini-flail	III-C	Shortcoming
26. Chains limit upward travel	IV-A	Shortcoming
27. Chains become entangled during flailing and sweeping operations	III-D	Suggested Improvement
28. Incorrect on and off positions of control located on rear panel	I-C	Deficiency
29. No label on fuel fill		

## REFERENCES

Department of Defense (14 April 1986). Lamps, reflectors, and associated signaling equipment for military vehicles (MIL-STD-1179D). Washington, DC: Author

Department of Defense (14 March 1989). Human engineering design criteria for military systems, equipment, and facilities (MIL-STD-1472D). Washington, DC: Author.

Department of Defense (13 August 1990). Identification coding and application of hook-up and lead wire (MIL-STD-681D). Washington, DC: Author

U.S. Army Belvoir Research, Development, and Engineering Center (October 1992). Low intensity conflict countermine mini-flail operator's manual of instruction. Ft Belvoir, VA: Author.

U.S. Army Test and Evaluation Command (8 Sep 1995). Conditional safety confirmation of the EOD/LIC mini-flail system (Memorandum, TECOM Proj No. 8-ES-045-MBT-003). Aberdeen Proving Ground, MD: Author.

U.S. Army Test and Evaluation Command (15 May 1990). Human factors engineering (Test Operations Procedure 1-2-610). Aberdeen Proving Ground, MD: Author.

U.S. Army Test and Evaluation Command (7 April 1986). System safety engineering (Test Operations Procedure 1-1-060). Aberdeen Proving Ground, MD: Author.

U.S. Army Test and Evaluation Command (1 April 1979). Classification of deficiencies and shortcomings (Test Operations Procedure 1-1-012). Aberdeen Proving Ground, MD: Author.

U.S. Army Test and Evaluation Command (20 July 1975). Questionnaire and interview design (TECOM Pamphlet 602-1, Volume 1). Aberdeen Proving Ground, MD: Author.

**APPENDIX A**

**INSTRUCTIONS FOR PROPER PLACEMENT OF  
MINI-FLAIL STENCILS AND LABELS**

## INSTRUCTIONS FOR PROPER PLACEMENT OF MINI-FLAIL STENCILS AND LABELS

1/4"

(a) **OFF** - The "OFF" and "ON" operational positions of the toggle switch located on the exterior rear panel of the Mini-flail need to be corrected so that "OFF" is the left position and "ON" is the right position. Generally, control movement forward, clockwise, to the right, or up, or pressing a control shall turn the equipment or component on, cause quantity to increase, or cause forward, clockwise, to the right, or upward movement in accordance with MIL-STD-1472D, paragraph 5.4.1.2.1. Labeling should then be modified to correspond with the appropriate operational positions.

Apply "OFF" to the exterior rear panel of the Mini-flail. "OFF" should be painted to the **left** of the toggle switch which is located closest to the top or hood and switches on a horizontal plane. If the operational positions have not been corrected, apply "OFF" to the right of the toggle switch.

(b) **ON** - Apply to the exterior rear panel of the Mini-flail. "ON" should be painted to the **right** of the toggle switch which is located closest to the top or hood and switches on a horizontal plane. If the operational positions have not been corrected, apply "ON" to the left of the toggle switch. Refer to (a) for additional discussion.

(c) **SWEEP** - Apply to the exterior rear panel of the Mini-flail. "SWEEP" should be painted **above** the toggle switch which is located just below the red Emergency Stop pushbutton and is positioned in the bottom, right quadrant of the rear panel. This control switches on a vertical plane.

(d) **FLAIL** - Apply to the exterior rear panel of the Mini-flail. "FLAIL" should be painted **below** the toggle switch which is located just below the Emergency Stop pushbutton and is positioned in the bottom, right quadrant of the rear panel. This control switches on a vertical plane.

(e) **REMOTE, OFF, ON, START** - Apply to the exterior rear panel of the Mini-flail. "REMOTE", "OFF", "ON", and "START" should be painted in respective, clockwise order of the **ignition control** key positions. Key positions start at approximately the 1300 hour position and end at the 1700 hour position. These letters may be too large to accommodate all position labels of the ignition; therefore, a paint pen may be used to label by free hand.

(f) **EMERGENCY STOP** - Apply to the exterior rear panel of the Mini-flail. "EMERGENCY STOP" should be painted above the pushbutton control; however, due to space limiting factors, it is suggested that the label be placed to the **left** of the red pushbutton control.

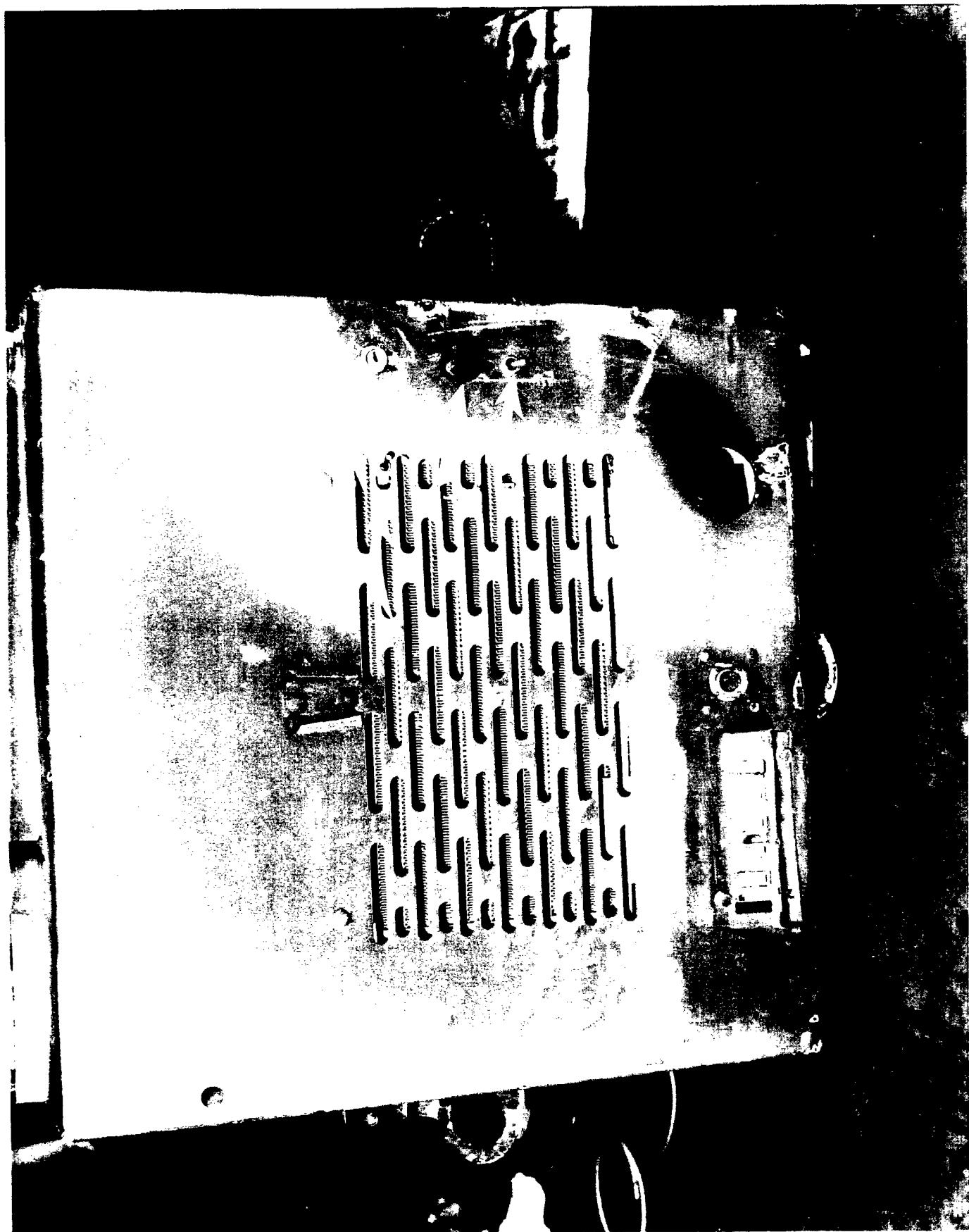
1/2"

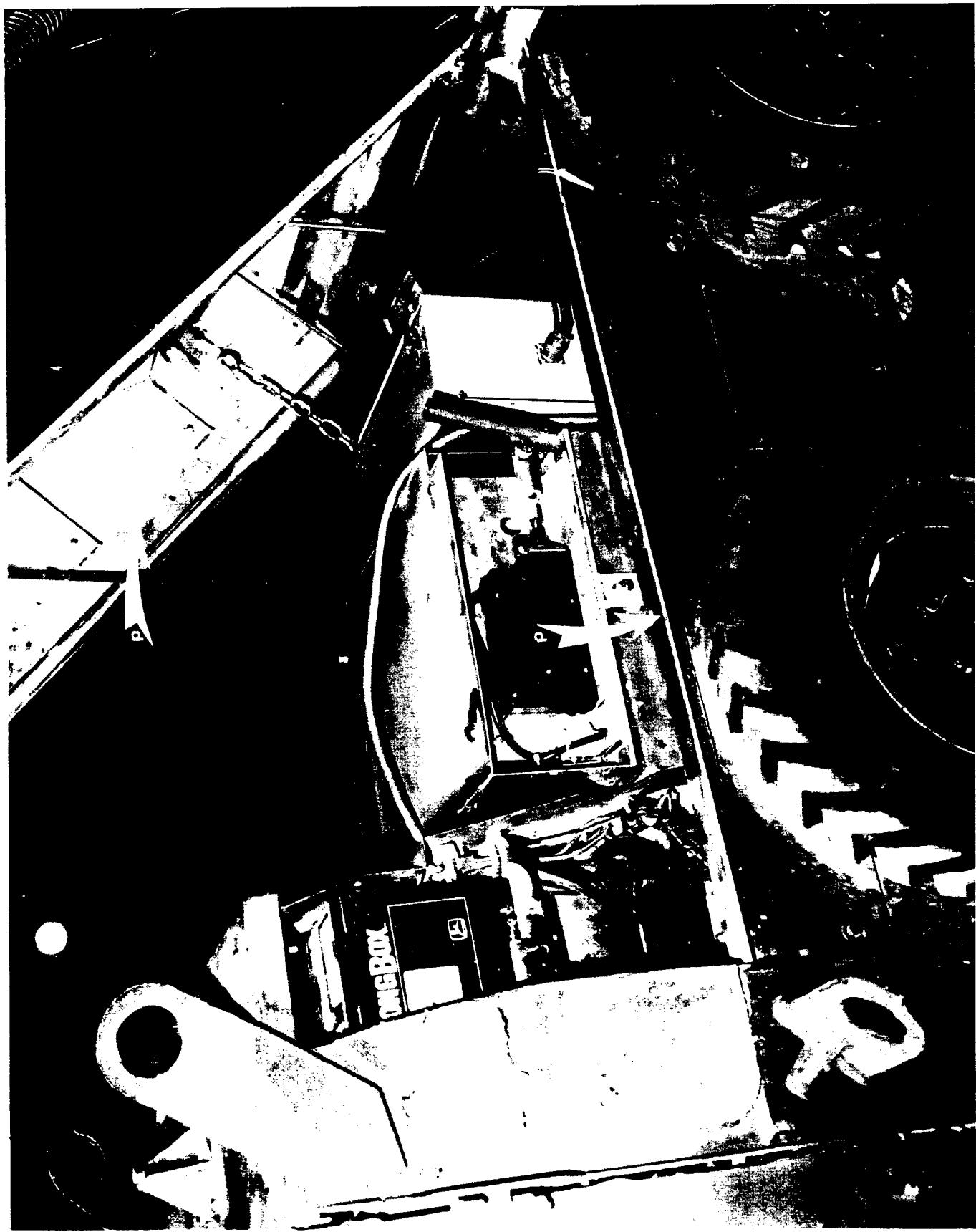
- (g) **TIE DOWN** - Apply "TIE DOWN" on or in close proximity to each of the four tie down eyes; two located near the front and two located near the rear of the Mini-flail. Due to space limitations, the stencil may have to be cut so that "TIE" is located above "DOWN".
- (h) **LIFT** - Apply "LIFT" on or in close proximity to each of the four lift eyes; two located near the front and two located near the rear of the Mini-flail.
- (i) **TRIP WIRE** - The Trip Wire mount is located on the top and to the rear of the Mini-flail, centered between the two rear lift eyes. Due to limited space, it is suggested that the "TRIP WIRE" label be applied to either side of the mount. It is also suggested that the stencil be cut so that "TRIP" is positioned above "WIRE". In addition, "TRIP WIRE" may also be applied to the lateral side, beneath the mount.
- (j) **ANTENNA** - The antenna mount is located on the top and to the extreme right, rear of the Mini-flail. "ANTENNA" should be painted to the **left** of the mount. Additionally, it may be positioned to the lateral side, beneath the mount.
- (k) **DIESEL ONLY** - The fuel fill is located to the left of the antenna mount (top, left, rear of the Mini-flail). "DIESEL ONLY" should be applied to the **left** of the fuel fill as space permits.
- (l) **NO STEP** - "NO STEP" should be positioned on the **top, left and right** sides of the Mini-flail hood so that the user may read the label while standing on either side.
- (m) **HOT** - Apply "HOT" above the exhaust located on the exterior, rear panel of the Mini-flail.
- (n) **STAND CLEAR - 100 M FOR FLYING DEBRIS 200 M FOR ANTI PERSONNEL MINES** - Apply "STAND CLEAR..." to the right and left lateral panels of the Mini-flail before the "HEARING PROTECTION..." label. Center label from left to right and position from top to bottom as space allows.
- (o) **HEARING PROTECTION REQUIRED WITHIN 7 FT WHEN ENGINE IS RUNNING** - Apply "HEARING PROTECTION..." to the right and left lateral panels of the Mini-flail. Center label from left to right and position from top to bottom as space allows.
- (p) **SECURE HOOD PROPERLY BEFORE PERFORMING MAINTENANCE** - Apply "SECURE HOOD..." on the top exterior hood panel oriented across the width of the item between both rear lift eyes with the letters oriented so personnel can read it from the front. Additionally, paint "SECURE HOOD..." on the interior left and right side ledges above the wheels or on the interior lateral hood panels so personnel will view the label before and after opening the hood from either side of the Mini-flail.

1/8" (Remote adhesive labels)

- (q) **FLAIL START** - Apply "FLAIL START" next to the red pushbutton located on the top of the wireless remote as space allows.
- (r) **BATTERY** - Apply "BATTERY" under the battery meter on the wireless remote as space allows.
- (s) **CAUTION - DO NOT RAISE FLAIL HEAD TOO HIGH** - Apply "CAUTION - DO NOT RAISE..." to the face of the remote control panel as space allows.

ATTENTION: THE ENCLOSED STENCILS (USED TO APPLY PAINTED LETTERING) ARE CONSIDERED PERMANENT; HOWEVER, THE ADHESIVE-TYPE LABELS ARE CONSIDERED TO BE TEMPORARY ONLY.









<u>NO. OF COPIES</u>	<u>ORGANIZATION</u>
2	ADMINISTRATOR DEFENSE TECHNICAL INFO CENTER ATTN DTIC DDA 8725 JOHN J KINGMAN RD STE 0944 FT BELVOIR VA 22060-6218
1	DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL OP SD TA/ RECORDS MANAGEMENT 2800 POWDER MILL RD ADELPHI MD 20783-1197
1	DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL OP SD TL/ TECHNICAL LIBRARY 2800 POWDER MILL RD ADELPHI MD 20783-1197
1	DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL OP SD TP/ TECH PUBLISHING BRANCH 2800 POWDER MILL RD ADELPHI MD 20783-1197
<u>ABERDEEN PROVING GROUND</u>	
2	DIRECTOR US ARMY RESEARCH LABORATORY ATTN AMSRL OP AP L (TECH LIB) BLDG 305 APG AA
1	LIBRARY ARL BUILDING 459 APG-AA

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
	November 1996	Final	
4. TITLE AND SUBTITLE		5. FUNDING NUMBERS	
Human Factors Engineering Assessment of the Mini-Flail System		AMS Code 622716.H700011 PR: 1L162716AH70 PE: 6.27.16	
6. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NUMBER	
Burcham, P.M.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
U.S. Army Research Laboratory Human Research & Engineering Directorate Aberdeen Proving Ground, MD 21005-5425		ARL-TN-79	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE	
Approved for public release; distribution is unlimited.			
13. ABSTRACT (Maximum 200 words)			
A human factors engineering (HFE) assessment was conducted on the mini-flail system whose basic mission is to neutralize anti-personnel hazards. The assessment revealed numerous HFE design problem areas. Recommendations for design modifications to fulfill the military standard requirements are discussed.			
14. SUBJECT TERMS		15. NUMBER OF PAGES	
assessment control and display	human factors labeling	mine-cleaning	35
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	